UK COURSE CORRECTED FUZE RESEARCH

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DERA

The Need For Competent Munitions

- Maximum range of artillery is increasing
- UK 155 mm artillery maximum range increased from 24 km to 35 km
- The Fall of Shot dispersion at these longer ranges is considerably greater than at current ranges
- The aims of Competent Munitions are to reduce the dispersion of current spin stabilised projectiles to retain artillery effectiveness at longer ranges

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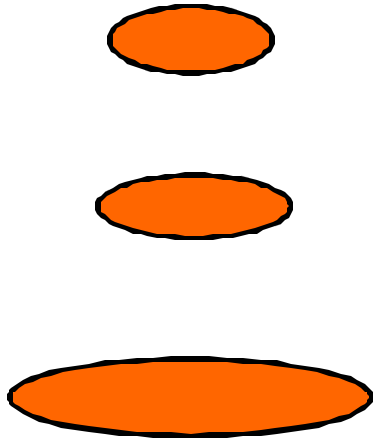
Increasing Artillery Dispersion

	RANGE (km)	Normalised Range Error
Conventional Gun & Shell	25	1.0
Conventional Gun & Base Bleed Shell	29	1.2
Extended Range Gun & Base Bleed Shell	35+	2.3



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Competent Munitions Options

- Possible alternatives:
  - GPS Auto-registration
  - Projectile Tracking System
  - 1D (range only) correction
  - 2D (range and line) correction
- UK research concentrated on 1D course correction concept

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Competent Munitions Research

- DERA has recently completed a 4 year Technology Demonstrator Programme to investigate a 1D Course Corrected Fuze (CCF) Concept
- 1D CCF is also being researched in the UK by Team STAR
- Other competent munitions options researched by ARDEC and ARL under complementary US programmes
- UK/US collaboration under TRDP MOU

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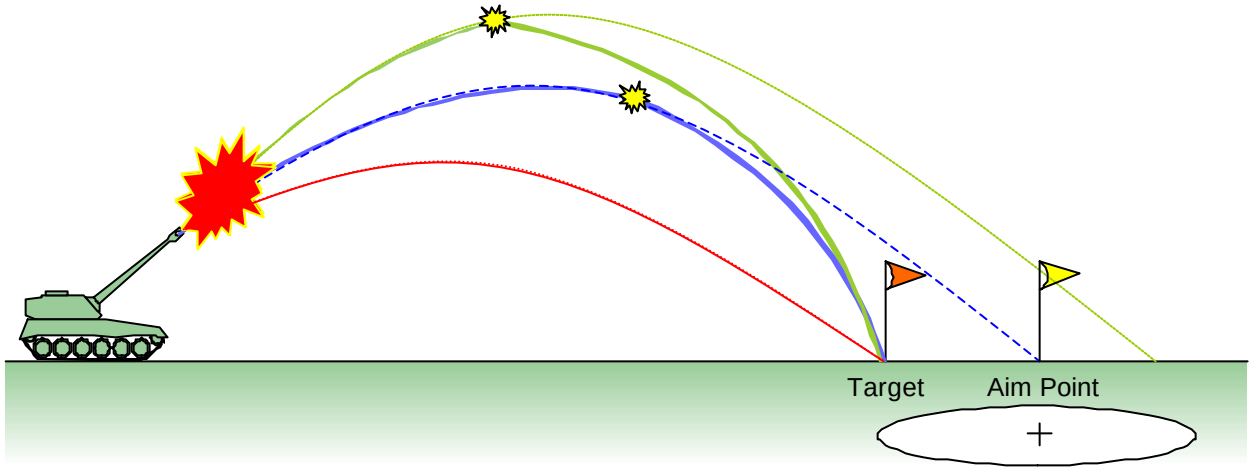
CCF Concept of Operation



Case 1 - No Errors
Case 2 - Over Shoot Error
Case 3 - Minimum Undershoot Error

Drag Device Deployed

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CCF Elements

- Control mechanism - Single shot drag brake
- Sensor - P(Y) code GPS receiver (antenna & oscillator)
- Initialisation - Inductive transfer
- Control algorithm - On-board software
- Fuzing - HE and Carrier

- All packaged within a standard NATO fuze intrusion envelope

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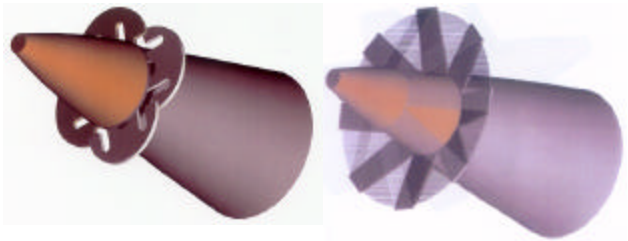
Drag Brakes (1)



- Several options considered
- Extensive subsystem tests (spin rig, catapult & air gun)
- Gun firing tests conducted Dec 97 & June 98
- Demonstrated proof of concept on both L15 & L20
- 2.9 times drag achieved
- No Instability detected

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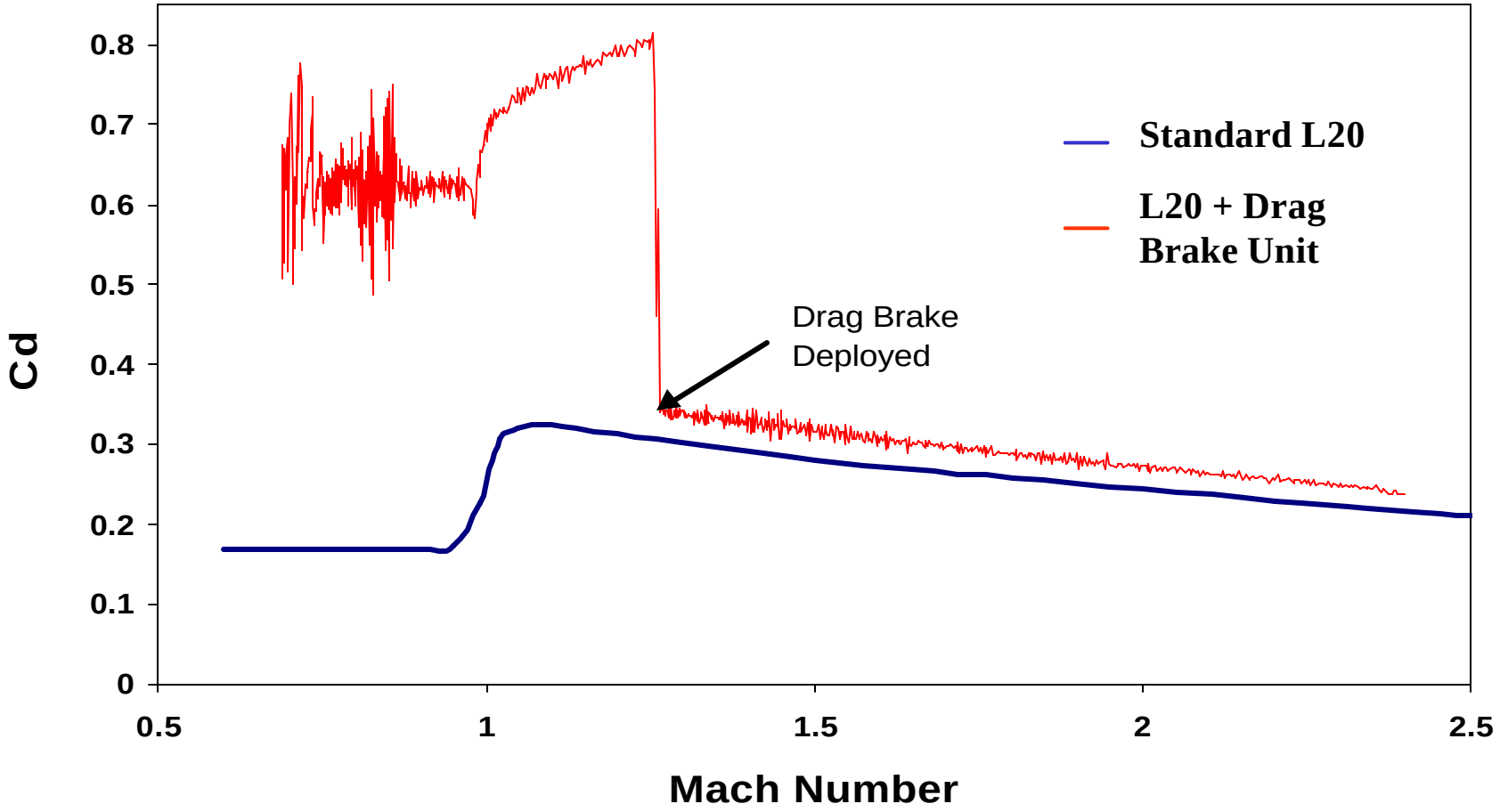
Drag Brakes (2)



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GPS Environmental Tests

- Series of subsystem hardware tests
  - Catapult
  - Gun firing trials
- Shoeburyness firing trial - Feb 1999
  - First demonstration of GPS performance in spin-stabilised shell
- Yuma firing trial - Aug 1999
  - Demonstration under maximum in-service firing conditions
    - US Charge M203A 8R
    - 14,500g setback acceleration for ~ 10 ms
    - Spin rate ~ 275 Hz
    - Muzzle velocity ~ 850 ms^{-1}

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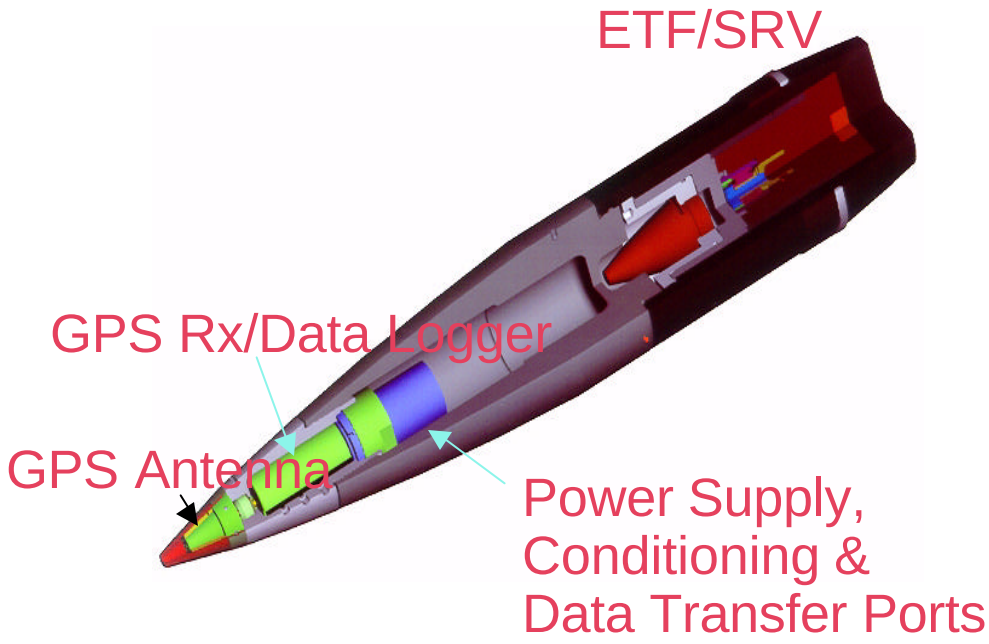
Test Vehicle for GPS Trials



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GPS Oscillators

- Provides accurate time reference for GPS
- Gun firing issues
  - Survivability
  - Frequency shift
- GPS gun firing trials
  - All survived
  - All within tolerance
  - Proven at max charge

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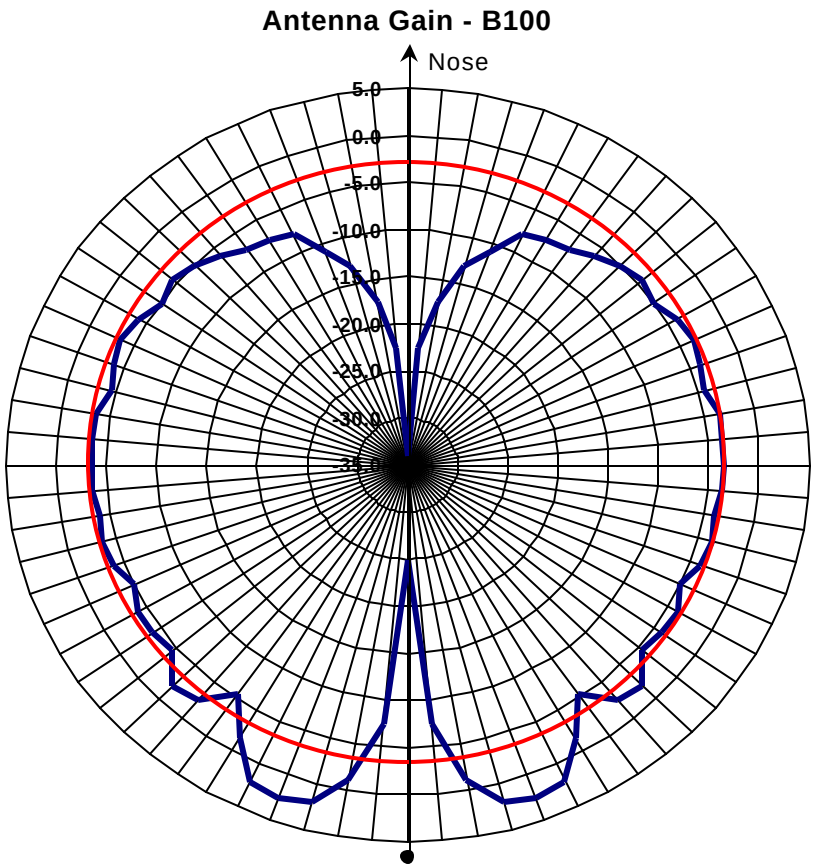
GPS Antenna



- Mechanical
  - Robust
  - Fits in conical profile of fuze
  - Novel annular slot design
- Electrical
  - Optimised for L1
  - VSWR < 1.5 to 1
  - -4.5dBiC average gain
  - -3dBiC gain at 90°
  - < 10° phase variation in roll plane

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GPS Receiver

- Rockwell Collins PPS GPS Receiver
- GPS and solid state data recorder mounted in 4in x 2in diameter ‘Soda Can’
- 12 Channel P(Y)-code
- Operating on GPS L1 Frequency (1575.42MHz)

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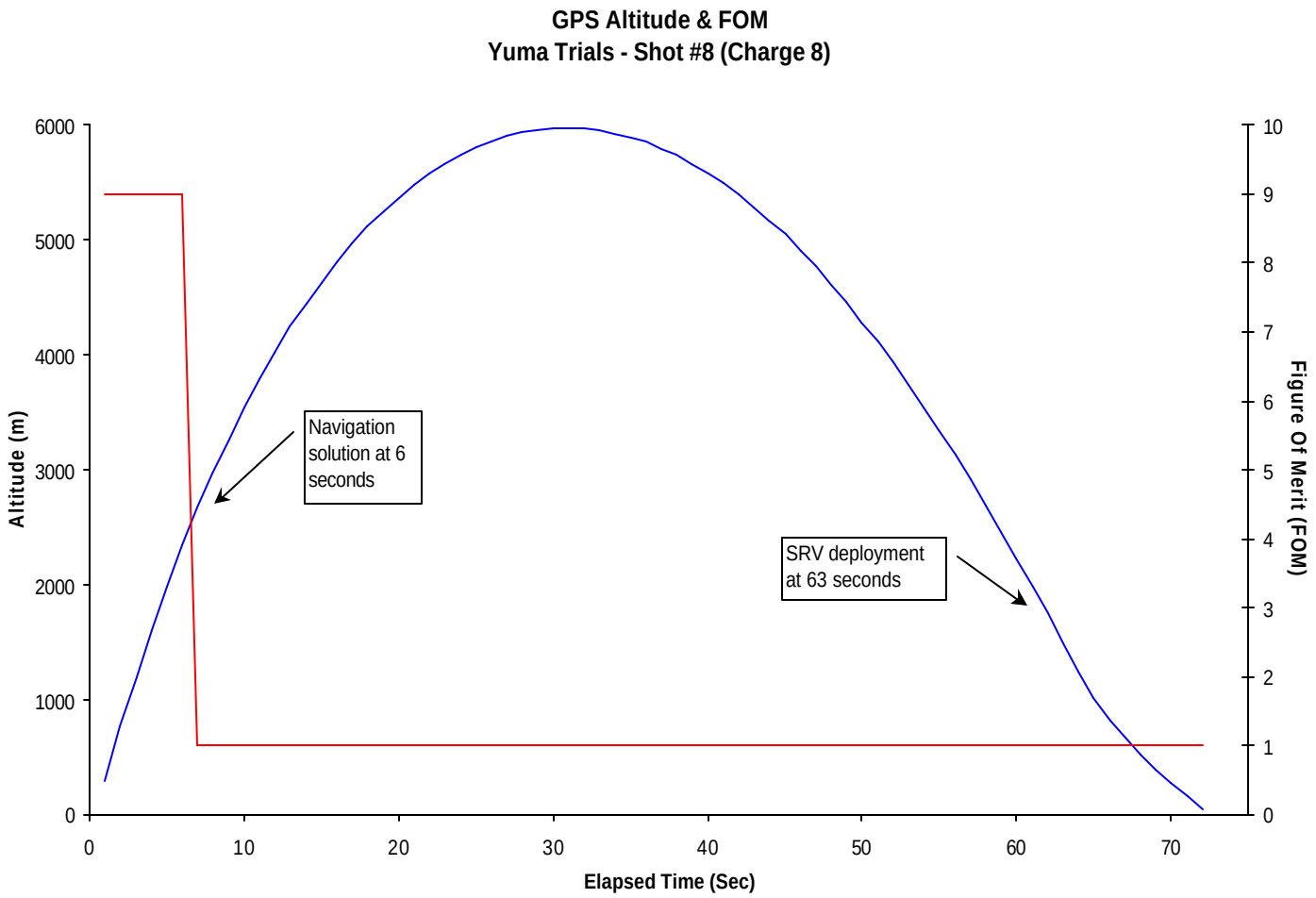
GPS Results (1)



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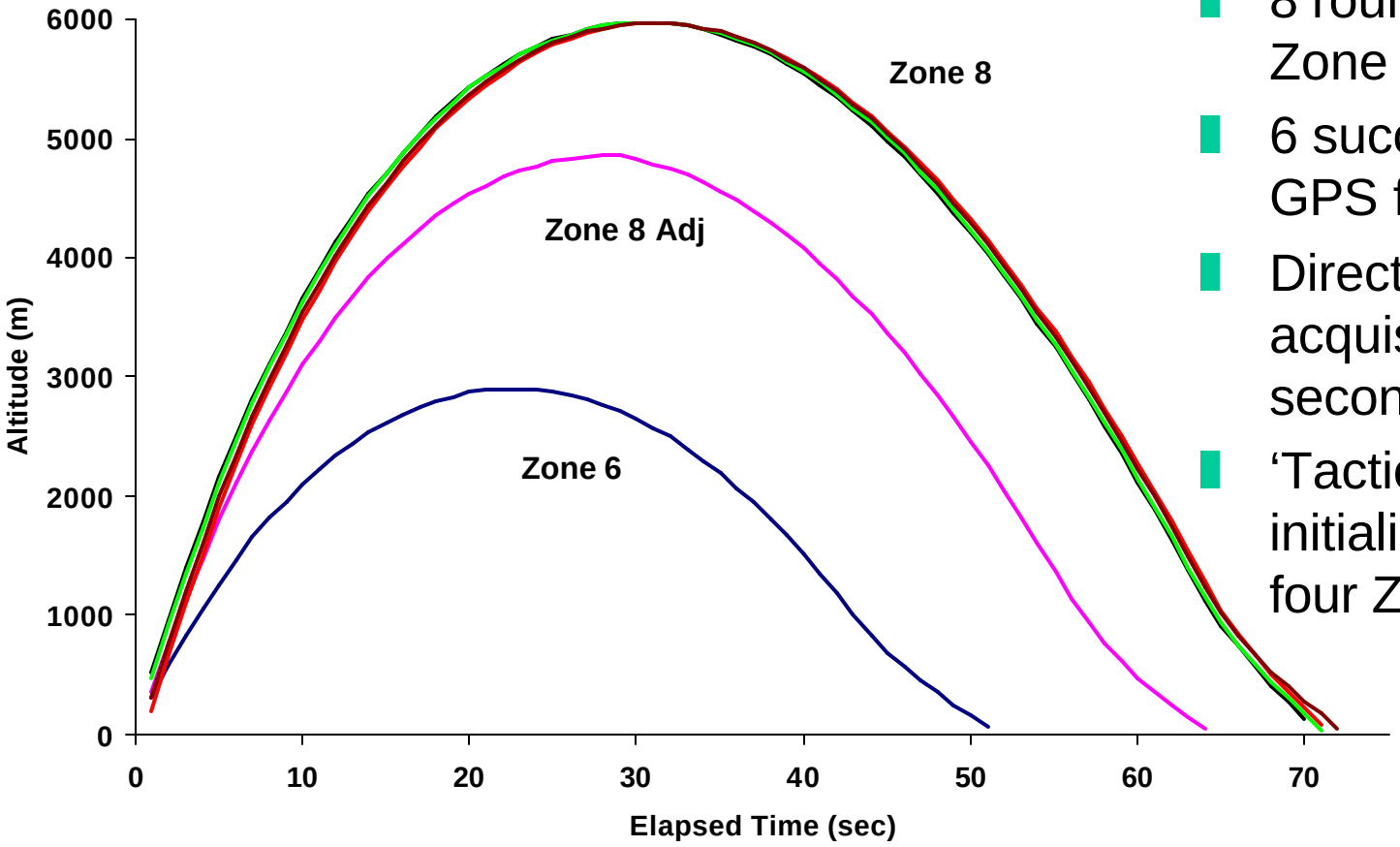
GPS Results (2)



- 8 rounds fired at Zone 6 to Zone 8
- 6 successes. 2 non-GPS failures
- Direct P(Y)-code acquisition in 3 seconds
- ‘Tactical’ initialisation of all four Zone 8 firings

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Initialisation

- Current requirements ~ 20 bits of data
- CCF requires GPS, target and trajectory ~ 25Kbits of data
- Initialisation is required within 2 seconds
- Current initialisation standards are not suitable for CCF
- Viability of inductive data transfer shown in hardware demonstration

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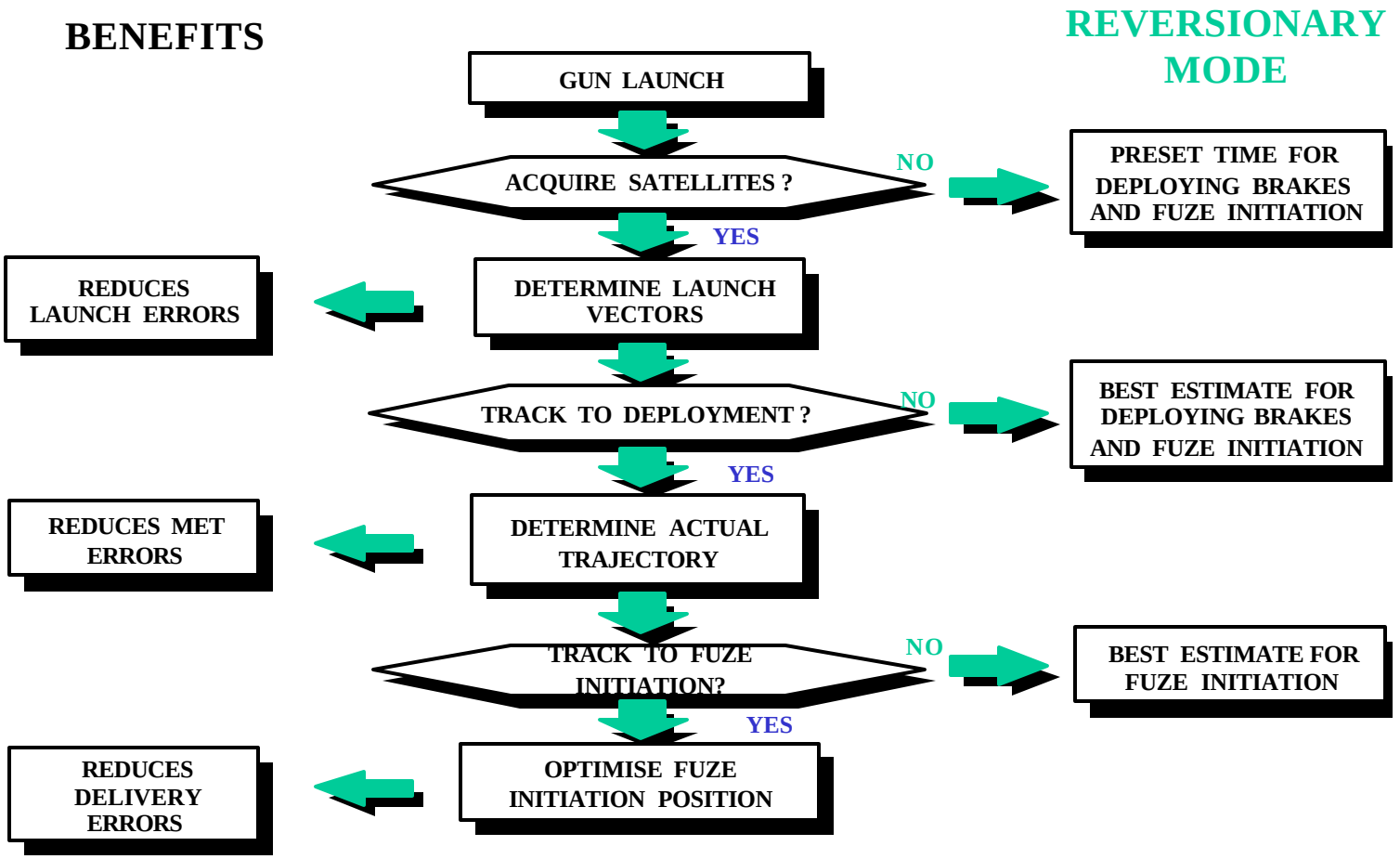
Course Correction Algorithm



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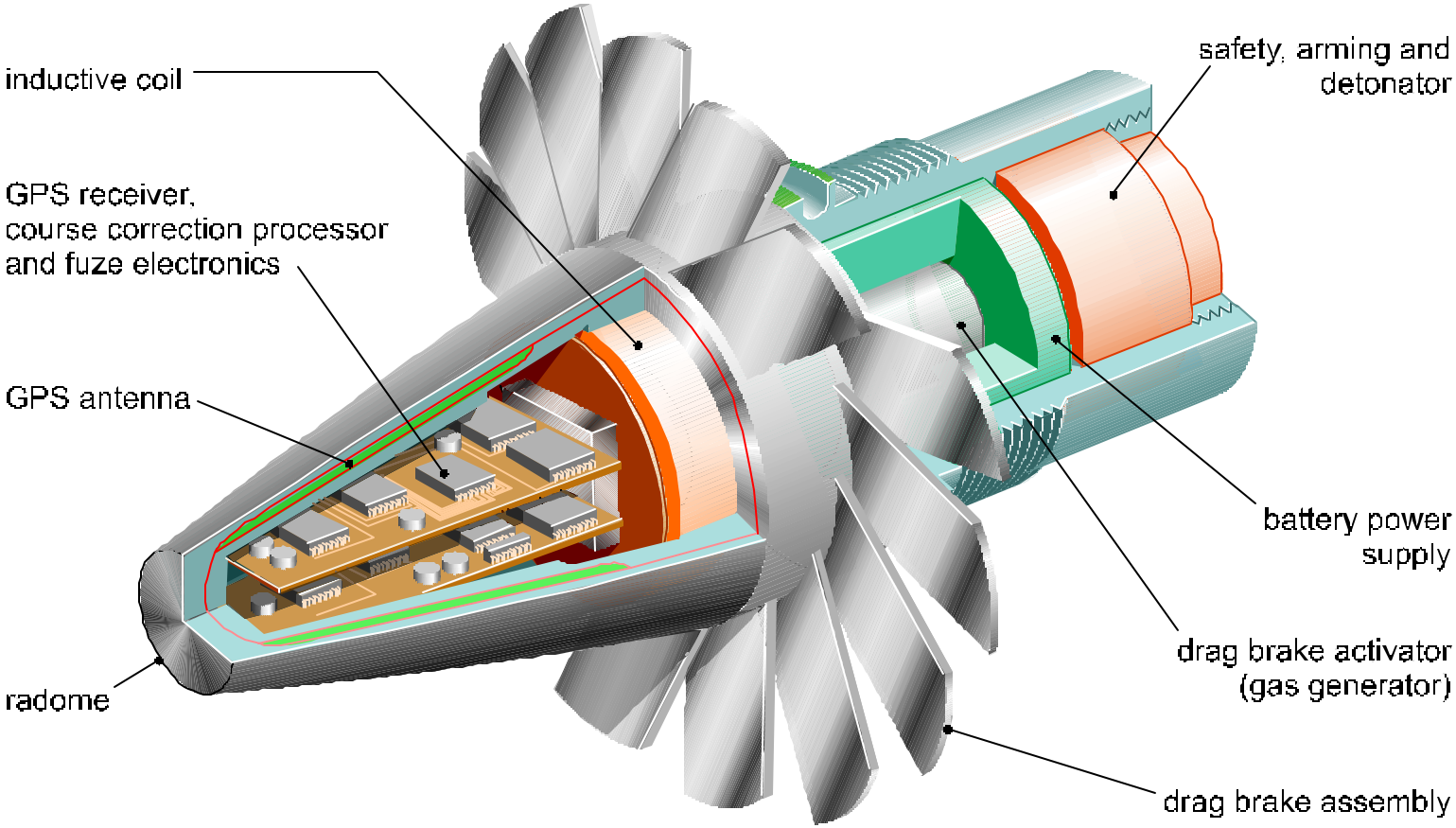
Packaging



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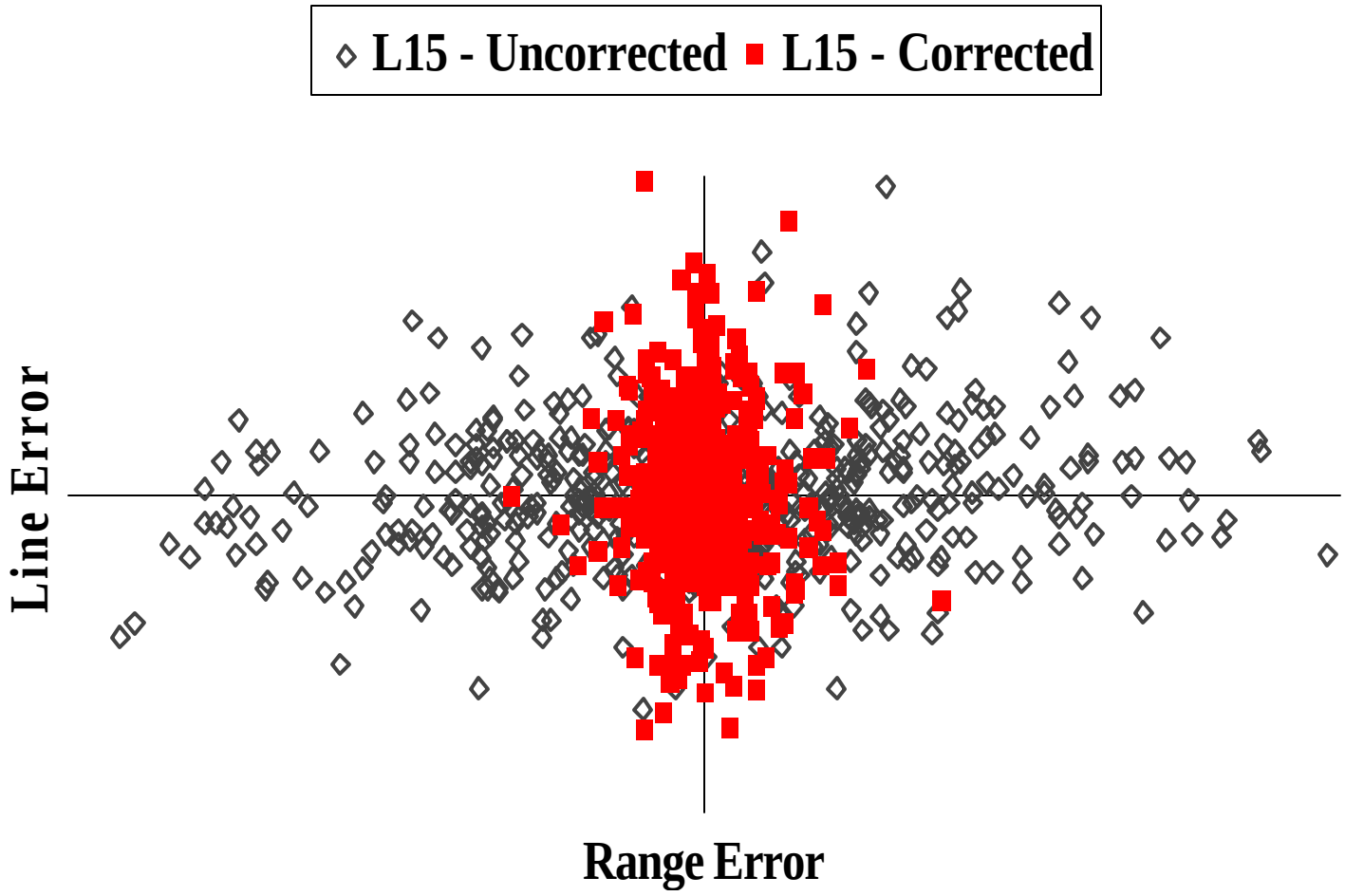
Effects of CCF on Dispersion



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DERA TDP Summary

- The TDP successfully demonstrated the following subsystems required for a CCF at max charge conditions
  - Drag brake
  - GPS receiver (including oscillator and antenna)
- Technical risks are now well understood and have been significantly reduced
- Effectiveness modelling (based on trials data) predicts that a CCF can provide a significant increase in artillery performance

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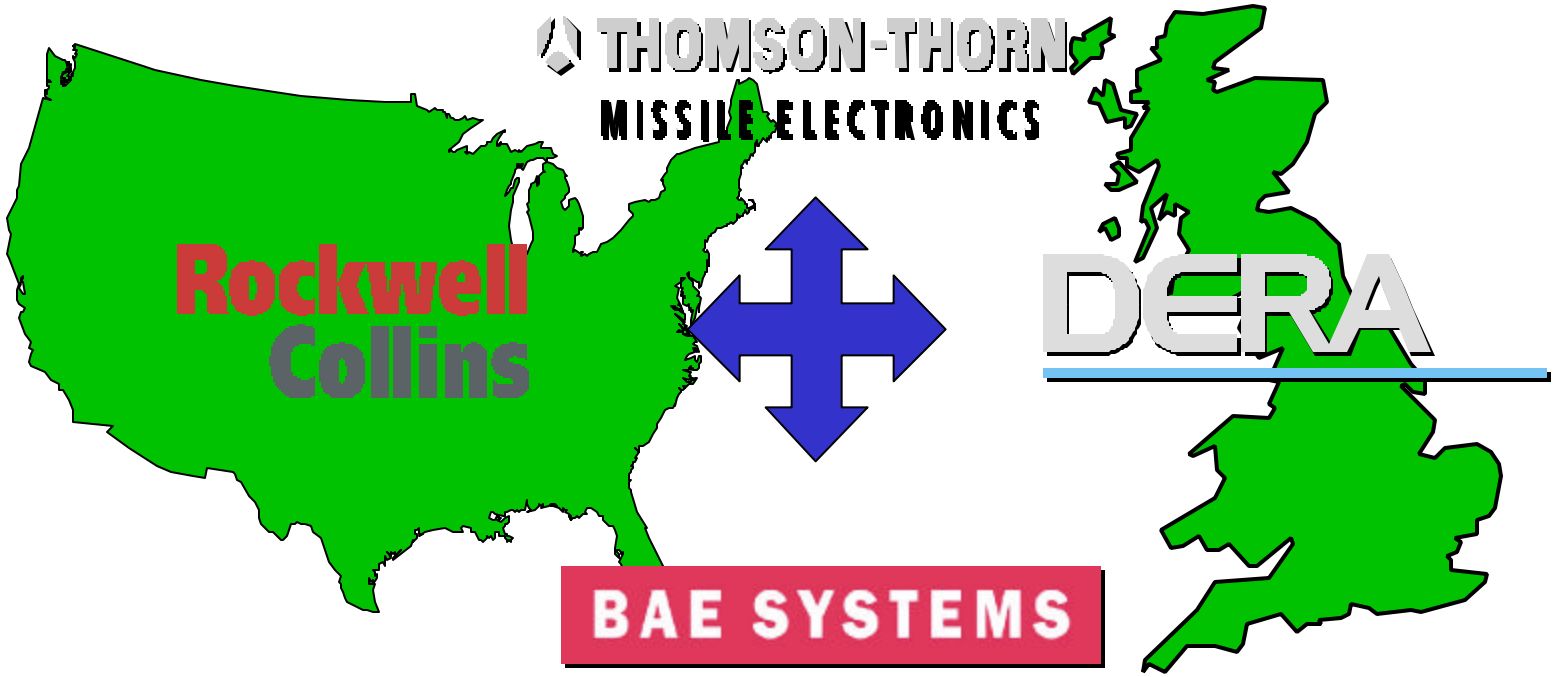
Team STAR



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Team STAR Programme

- Team STAR has been researching 1D course correction for several years
- Team STAR has recently completed a successful 2 year Technology Demonstrator Programme
  - Product based
  - In parallel with and complementary to DERA TDP
  - culminated in successful demonstration of integrated 1D course correction hardware at YPG in August 1999

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Future 1D CCF

- The DERA TDP demonstrated the viability of the concept at the subsystem level
- The Team STAR TDP demonstrated integration of 1D course correction hardware
- Building on these successes, a Course Corrected Fuze solution is now being taken forward to a future product by Team STAR

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Points of Contact

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